UTILITY PATENT APPLICATION TRANSMITTAL (Only for new nonprovisional applications under 37 CFR 1.53(b))	Attorney Docket No.	196261US55DIV
	First Inventor or Application Identifier	STUCKY David
	Title	FOAMED POLYMER-FIBER COMPOSITE

11/13/00 JC803 U.S. PTO

JC841 U.S. PTO 09/709527 11/13/00

APPLICATION ELEMENTS See MPEP chapter 600 concerning utility patent application contents	ADDRESS TO: Assistant Commissioner for Patents Box Patent Application Washington, DC 20231

APPLICATION ELEMENTS

1. ■ Fee Transmittal Form (e.g. PTO/SB/17) (Submit an original and a duplicate for fee processing)
2. ■ Specification — Total Sheets: 19
3. ■ Drawing(s) (35 U.S.C. 113) — Total Sheets: 3
4. ☐ Oath or Declaration — Total Pages:
   - a. ☐ Newly executed (original or copy)
   - b. ☐ Copy from a prior application (37 C.F.R, §1.63(d)) (for continuation / divisional w/ box 16 completed)
     - i. ☐ DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §1.63(d)(2) and 1.33(b).
5. ☐ CD-ROM or CD-R in duplicate, large table or Computer Program (Appendix)
6. ☐ Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary)
   - a. ☐ Computer Readable Form (CRF)
   - b. Specification or Sequence Listing on:
     - i. ☐ CD-ROM or CD-R (2 copies); or
     - ii. ☐ Paper
   - c. ☐ Statements verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

7. ☐ Assignment Papers (cover sheet & document(s))
8. ☐ Application Data Sheet. See 37 CFR 1.76
9. ☐ 37 C.F.R. §3.73(b) Statement (when there is an assignee) ☐ Power of Attorney
10. ☐ English Translation Document (if applicable)
11. ■ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations
12. ■ Preliminary Amendment
13. ■ White Advance Serial No. Postcard
14. ☐ Certified Copy of Priority Document(s) (if foreign priority is claimed)
15. ☐ Applicant claims small entity status. See 37 CFR 1.27
16. ■ Other: (1) Copy of Revocation and New Power of Attorney
    (2) Request for Priority

16. If a CONTINUING APPLICATION, *check appropriate box, and supply the requisite information below:*

☐ Continuation ■ Divisional ☐ Continuation-in-part (CIP) of prior application no.: 09/055,098

Prior application information: Examiner: Copenheaver Group Art Unit: 1771

For CONTINUATION OR DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

17. Amend the specification by inserting before the first line the sentence:

■ This application is a ☐ Continuation ■ Division ☐ Continuation-in-part (CIP) of application Serial No. 09/055,098 Filed on April 3, 1998, now pending.

☐ This application claims priority of provisional application Serial No. Filed

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Docket No. 196261US55DIV

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

INVENTOR(S) STUCKY David et al.
SERIAL NO: New Divisional Application
FILING DATE: Herewith
FOR: FOAMED POLYMER-FIBER COMPOSITE

jc841 U.S. PTO 09/709527 11/13/00

FEE TRANSMITTAL

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

FOR	NUMBER FILED	NUMBER EXTRA	RATE	CALCULATIONS
TOTAL CLAIMS	6 - 20 =	0	× $18 =	$0.00
INDEPENDENT CLAIMS	1 - 3 =	0	× $80 =	$0.00
☐ MULTIPLE DEPENDENT CLAIMS (If applicable)			+ $270 =	$0.00
☐ LATE FILING OF DECLARATION			+ $130 =	$0.00
			BASIC FEE	$710.00
			TOTAL OF ABOVE CALCULATIONS	$710.00
☐ REDUCTION BY 50% FOR FILING BY SMALL ENTITY				$0.00
☐ FILING IN NON-ENGLISH LANGUAGE			+ $130 =	$0.00
☐ RECORDATION OF ASSIGNMENT			+ $40 =	$0.00
			TOTAL	$710.00

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■ A check in the amount of **$710.00** to cover the filing fee is enclosed.

■ The Commissioner is hereby authorized to charge any additional fees which may be required for the papers being filed herewith and for which no check is enclosed herewith, or credit any overpayment to Deposit Account No. 15-0030. A duplicate copy of this sheet is enclosed.

Respectfully Submitted,

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DOCKET NO.: 196261US55DIV

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF:	:	GROUP ART UNIT:
DAVID STUCKY et al.	:	
SERIAL NO.: NEW DIVISIONAL APPL.	:	EXAMINER:
FILED: HEREWITH	:	
FOR: FOAMED POLYMER-FIBER COMPOSITE	:	

PRELIMINARY AMENDMENT

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

SIR:

Prior to examination on the merits, please amend the above-identified application as follows.

IN THE CLAIMS

Please cancel Claims 1-14 and Claims 18-20, without prejudice.

Please amend the claims as follows:

15. (Amended) A method of forming a foamed [polymer-cellulosic] composite building material, comprising:

(a) compounding about [35-75 wt. %] one hundred parts polymeric resin, about [25-65 wt. % cellulosic] 68 parts to about 100 parts fiber per hundred parts polymeric resin, and about [0.1 to 2 wt. %] 0.5 to about 1.5 parts of a blowing agent per hundred parts polymeric resin to form a compounded mixture;

(b) feeding said compounded mixture into an extruder [, whereby said

mixture becomes molten and said blowing agent generates a gas that is dispersed within said mixture]; and

(c) extruding said molten mixture containing said gas through a die.

16. (Amended) The method of claim 15 wherein said compounded mixture further comprises an acrylic modifier [for increasing melt elasticity and strength].

Please add new Claims 21-23 as follows:

--21. The method of claim 16 wherein the amount of said acrylic modifier is from about 4 parts to about 10 parts per hundred parts of polymeric resin.

22. The method of claim 15 wherein said foamed material has a specific gravity less than about 1.2 g/cc.

23. The method of claim 15 wherein said foamed composite material has a flexural modulus of from about 100,000 to about 450,000 psi.--

IN THE SPECIFICATION

On page 1 of the specification, on the line following the title line and before the line that reads "Field of the Invention," please insert:

--This is a division of application Serial No. 09/055,098, filed April 3, 1998, which application is hereby incorporated herein by reference in its entirety.--

STATUS OF THE CLAIMS

Claims 1-20 were pending in the parent application.

Claims 1-14 and 18-20 are being canceled by the present Amendment.

Claims 15 and 16 are being amended.

Claims 21-23 are being added.

Claims 15-17 and 21-23 are now pending in the application.

REMARKS

The present application is a divisional of parent application Serial No. 09/055,098 and is being amended to cancel subject matter claimed in the parent application.

Claim 15 is being amended to recite the claimed quantities of polymeric resin, fiber and blowing agent in parts per hundred. This amendment is being made for clarity. This amendment introduces no new matter and is supported in the specification as filed, *inter alia*, on page 13 in Table 1.

Claim 16 is being amended to remove the redundant recitation of "for increasing melt elasticity and strength," and to more particularly point out and distinctly claim Applicants' invention.

Claims 21-22 are being added to claim several specific embodiments of the present invention. Claim 21 recites the amount of acrylic modifier in the composite material, and is supported in the original specification, *inter alia*, on page 13 in Table 1. Claim 22 recites that the foamed composite material has a specific gravity of less than about 1.2 g/cc and is supported in the original specification, *inter alia*, on page 13 in Table 1. Claim 23 recites that the foamed composite material has a flexural modulus from about 100,000 to about 450,000 and is supported in the original specification, *inter alia*, on page 3, lines 12-14.

Accordingly, and in view of the above amendment, Applicants respectfully requests early action on the merits in this case.

Respectfully submitted,

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PATENT

FOAMED POLYMER-FIBER COMPOSITE

Field of the Invention

This invention relates to polymer-fiber composites used for the fabrication of decking, railing, siding and structural materials, and more particularly, to foamed composites which are lightweight and provide adequate strength and mechanical properties for building requirements.

Background of the Invention

Synthetic lumber has been used as a substitute for wood in areas where wood can deteriorate quickly due to environmental conditions. Although in the past, its commercialization was limited by costs, modern recycling techniques and low cost extrusion manufacturing capability have permitted greater penetration by polymer-fiber composite materials into the commercial and residential markets. One such product manufactured under the trademark TREX, by Trex Company, LLC, Winchester, VA, consists of a polyethylene-wood fiber blend which is extruded into board dimensions for decking applications. Polyethylene-wood composite boards in 5/4 inch thicknesses have sufficient rigidity to be used as decking planks, but typically are not recommended for structural wood substitutes, such as the lattice structure often used as a support for decks.

Polyethylene composites are attractive because they permit screw fasteners to "countersink", such that the heads of the screws bury or at least become flush with the board surface, without predrilling. These synthetic wood products are weather resistant and relatively maintenance free. Once installed, they resist splintering and warping normally associated with

wood boards. They are also characterized by "color weatherability"; for example, the TREX product initially is a light coffee brown color and converts to a weathered gray appearance when exposed to rain water and sunlight.

Polyethylene-wood composite boards do not require painting, and never include knots which often result in damage to the surface of ordinary wood lumber, and usually more difficult hammering or screwing of fasteners. These composite materials also do not shed sap, and have a smooth surface texture that is comfortable for even barefoot walking.

In addition to polyethylene, other plastics have been suggested for use in the manufacture of synthetic wood products. Polyvinyl-chloride ("PVC") thermoplastics have been used in combination with wood fibers to make extruded materials, for use in windows and doors, for example. See U.S. Patent No. 5,486,553 assigned to Andersen Corporation. Such components are designed to substitute for structural wooden members and typically have a tensile or Young's modulus of about 500,000 psi or greater. Because they are often load bearing, some of these wood fiber-PVC reinforced articles are dense, relatively heavy, and are believed to require predrilling in order to countersink a screw head.

Accordingly, there remains a need for a building material that is light weight, and can permit the countersinking of a screw head without predrilling. There also remains a need for an extrudable polymer-fiber composite that can be tinted in a variety of permanent or semi-permanent colors or to provide a weathered look.

SUMMARY OF THE INVENTION

This invention provides foamed polymer-fiber composite building materials which may include about 35-75 wt. % of the polymeric resin, about 25-65 wt. % fiber, and a specific gravity of less than about 1.25g/cc. The resulting composite includes a plurality of pores or cells therein resulting from the addition of a blowing agent or disbursed gas into a molten precursor of the composite.

The composites of this invention are nearly 10% lighter than non-foamed synthetic boards of similar composition. The preferred vinyl-resin boards are stiffer than polyethylene wood composites of similar thickness. PVC can be foamed through the addition of a blowing agent to a compounded mixture of resin and wood flour. This results in a preferred amount of porosity of at least about a 1% by volume of solids, concentrated primarily in a central region of the cross-section of extruded composite forms made from these mixtures. The tensile and flexural modulus of the preferred board-like members of this invention is less that about 500,000 psi, and generally about 100,000 to 450,000 psi. The resulting board-like surfaces permit the countersinking of screw heads without predrilling.

The polymer-fiber composites of this invention can also include additives for improving the melt strength of a molten precursor of the composite during extrusion operations. The preferred additives for this purpose include acrylic modifiers in amounts ranging from .1 to about 15 weight percent. Building materials made from such composites can be tinted to provide a weathered look through the addition of dyes, such as mixed metal oxides and titanium dioxide,

pigments, or flyash, for example. In order to reduce costs, larger wood flour particles greater than 30 mesh size can be used.

Brief Description of the Drawings

FIG. 1: is a partial, cross-sectional, front perspective view of a preferred foamed polymer-fiber composite building material of this invention;

FIG. 2: is a front perspective, partial view, of a deck construction and home using the preferred composite building materials of this invention;

FIG. 3: is a side, cross-sectional view of the composite building material of FIG. 1 illustrating a screw which has been inserted in a counter-sink relationship with a top surface of the building material;

FIG. 4: is a partial, cross-sectional, front perspective view of a preferred railing of this invention;

FIG. 5: is a graph depicting specific gravity versus wood flour concentration for the composites of this invention;

FIG. 6: is a graph depicting specific gravity versus acrylic modifier concentration for the composites of this invention;

FIG. 7: is a graph depicting specific gravity versus chemical blowing agent concentration for the composites of this invention;

FIG. 8: is a graph depicting flexural modulus versus wood flour concentration for the composites of this invention;

FIG. 9: is a graph depicting flexural modulus versus acrylic modifier concentration for the composites of this invention;

FIG. 10: is a graph depicting flexural modulus versus chemical blowing agent concentration for the composites of this invention;

FIG. 11: is a graph depicting flexural strength versus wood flour concentration for the composites of this invention;

FIG. 12: is a graph depicting flexural strength versus acrylic modifier concentration for the composites of this invention; and

FIG. 13: is a graph depicting flexural strength versus chemical blowing agent concentration for the composites of this invention.

Detail Description of the Invention

The foamed polymer-fiber composites of this invention can be used by themselves, or in conjunction with "capstock" or coextrusions of other materials, such as, for example, pure or copolymer resins, resins filled with wood or glass fiber, or additives, such as sand, to provide better traction, strength, ultraviolet protection or textures to provide a more wood-like appearance. This invention also pertains to a process for making foamed polymer-fiber composites, such as building materials, including roof shingles, siding, floor tiles, paneling, moldings, structural components, steps, door and window sills and sashes; house and garden items, such as planters, flower pots, landscape tiles, decking, outdoor furniture, fencing, and playground equipment; farm and ranch items, including pasture fencing, posts and barn components; and marine items, for example, decking, bulkheads and pilings.

As shown in the figures, and in particular, FIG. 1, there is shown a preferred foamed polymer-fiber composite 100 which includes about 35-75% of a polymeric resin, about 25-65% fiber with a specific gravity of less than about 1.25 g/cc, and preferably about .5-1.2 g/cc. This composite 100 includes a plurality of pores or cells defining porosity 20 therein resulting from the addition of a blowing agent or gas to a molten precursor of said composite 100. The porosity desirably measures at least about 1%, and preferably about 5-40% by volume of solids in the composite 100. The composites of this invention also may include one or more additives, such as a process aid, pigment, or plasticizer.

As shown in FIGS. 2-4, the foamed polymer-fiber composite 100 of this invention is ideally suited for decking, siding, railings, window frames, including styles and rails, and balusters. Even though the composite 100 is light-weight, it generally has a flexural modulus, tensile modulus, and/or Young's modulus of about 100,000 to 450,000 psi. As shown in FIG. 3, the composite 100 preferably allows screw and nail fasteners, such as screw 35, to be secured in a countersink relationship with the surface of the composite 100 or below the surface, without predrilling. This is generally accomplished by the use of plasticizing agents to lower the compression strength of the composite100, and/or by the careful use of blowing agents or gas in the molten precursor of the composite 100, so as to provide a cellular internal structure containing porosity 20 surrounded by a polymeric skin 10. This porosity, even without plasticizing agents, provides enough compressive strength relief to permit screw fasteners to countersink without predrilling. This permits a very attractive deck 40 of side-by-side composite boards as shown in FIG. 2. Ideally, for strength and cost considerations, the support structure and columns of the deck are made from wood.

Also as shown in FIG. 2, the preferred composite 100 can be fashioned, for example, by extrusion, in the shape of siding 55 or window frame components 58, such as styles or rails, for a house 50. As shown in FIG. 4, the composite 100 can also be shaped into a railing 45 or baluster 60.

The preferred materials of this invention will now be described in more detail. The composites generally contain about 35-75 wt.% resinous materials, such as thermoplastic and thermosetting resins, for example, PVC, polyethylene, polypropylene, nylon, polyesters,

polysulfones, polyphenylene oxide and sulphide, epoxies, cellulosics, etc. A preferred thermoplastic material for the panels of this invention is PVC. PVC thermoplastics comprise the largest volume of thermoplastic polymers in commercial use. Vinyl chloride monomer is made from a variety of different processes involving the reaction of acetylene and hydrogen chloride and the direct chlorination of ethylene. Polyvinyl chloride is typically manufactured by the free radical polymerization of vinyl chloride. After polymerization, polyvinyl chloride is commonly combined with impact modifiers, thermal stabilizers, lubricants, plasticizers, organic and inorganic pigments, fillers, biocides, processing aids, flame retardants or other commonly available additive materials, when needed. Polyvinyl chloride can also be combined with other vinyl monomers in the manufacture of polyvinyl chloride copolymers. Such copolymers can be linear copolymers, graft copolymers, random copolymers, regular repeating copolymers, block copolymers, etc. Monomers that can be combined with vinyl chloride to form vinyl chloride copolymers include acrylonitrile; alpha-olefins such as ethylene, propylene, etc.; chlorinated monomers such as vinylidene, dichloride; acrylate momoners such as acrylic acid, methylacrylate, methyl-methacrylate, acrylamide, hydroxethyl acrylate, and others; styrenic monomers such as styrene, alpha methyl styrene, vinyl toluene, etc.; vinyl acetate; or other commonly available ethylenically unsaturated monomer compositions. Such monomers can be used in an amount of up to about 50 mol-%, the balance being vinyl chloride. PVCs can be compounded to be flexible or rigid, tough or strong, to have high or low density, or to have any of a wide spectrum of physical properties or processing characteristics. PVC resins can also be alloyed with other polymers, such as ABS, acrylic, polyurethane, and nitrile rubber to improve

impact resistance, tear strength, resilience, or processability. They can be produced water-white in either rigid or flexible compositions, or they can be pigmented to almost any color.

In the preferred embodiments of this invention, rigid PVC, optionally containing a small amount of plasticizer, is employed. This material is a hard and tough and can be compounded to have a wide range of properties, including impact resistance and weatherability, e.g., fading color to a wood grey appearance. It also has a tensile strength of about 6,000-7,500 psi, a percent elongation of about 40-80%, and a tensile modulus of about $3.5\text{-}6.0\text{X}10^6$ psi. It can be acceptably used without chlorination, to about 140° F., and with chlorination to about 220° F. It also has a coefficient of thermal expansion of about $3\text{-}6\text{X}10^{-5}$ inch/inch-°F.

The composite building materials of this invention can be injection or vacuum molded, extruded and drawn, using customary manufacturing techniques for thermoplastic and thermosetting materials. In the preferred embodiment, a mixture of PVC regrind or virgin compound is compounded and then heated and extruded through a die to produce boards and other shapes having a length of about 4-20 feet and thicknesses ranging from .05 - 6.0 inches. The extruded thermoplastic boards can be subject to further molding, calendaring, and finishing to provide a wood grain or fanciful texture.

The building material 100 of this invention also can contain about 25-60 wt.% fiber, such as glass, wood, cotton, boron, carbon, or graphite fibers. Additionally, inorganic fillers, such as calcium carbonate, talc, silica, etc. can be used. Preferrably, the fibers are "cellulosic" in nature. Cellulosic fibers can be derived from recycled paper products, such as agrifibers, pulp, newsprint, soft woods, such as pine, or hard woods from deciduous trees. Hard woods are

generally preferred for fiber manufacture because they absorb less moisture. While hard wood is the primary source of fiber for the invention, additional fiber make-up can be derived from a number of secondary sources including soft wood fibers, natural fibers including bamboo, rice, sugar cane, and recycled or reclaimed fiber from newspapers, cardboard boxes, computer printouts, etc. This invention can utilize wood flour of about 10-100 mesh, preferably 20-30 mesh.

Preferably, this invention combines the resin and wood flour components with a chemical blowing agent, or introduces a gaseous medium into a molten mixture of the resin and wood fiber to produce a series of trapped bubbles prior to thermo-forming the mixture, for example, by molding, extrusion or co-extrusion. Such processes for making rigid foam articles are generally well known.

In the preferred processes of this invention, a quantity of PVC regrind in small chunks is mixed with 20-30 mesh wood flour of about grass-seed size which has been pre-dried to release any trapped moisture as steam. The mixture also includes a melt enhancer, such a high molecular weight acrylic modifier, which improves melt elasticity and strength and enhances cellular structure, cell growth and distribution.

A chemical blowing agent or gas can also be added to the mixture to reduce the density and weight of the composite 100 by foaming. If a chemical blowing agent is used, it is mixed into the compound during blending or at the feed throat of the extruder. In the extruder, the blowing agent is decomposed, disbursing gas, such as nitrogen or CO_2, into the melt. As the

melt exits the extrusion die, the gas sites experience a pressure drop expanding into small cells or bubbles trapped by the surrounding polymer.

Chemical blowing agents can be any of a variety of chemicals which release a gas upon thermal decomposition. Chemical blowing agents may also be referred to as foaming agents. The blowing agent, or agents, if more than one is used, can be selected from chemicals containing decomposable groups such as azo, N-niroso, carboxylate, carbonate, hetero-cyclic nitrogen-containing and sulfonyl hydrazide groups. Generally, they are solid materials that liberate gas when heated by means of a chemical reaction or upon decomposition. Representative compounds include azodicarbonamide, bicarbonates, dinitrosopentamethylene tetramethylene tetramine, p,p'-oxy-bis (ben-zenesulfonyl)-hydrazide, benzene-1,3-disulfonyl hydrazide, aso-bis-(isobutyronitrile), biuret and urea.

The blowing agent may be added to the polymer in several different ways which are known to those skilled in the art, for example, by adding the solid power, liquid or gaseous agents directly to the resin in the extruder while the resin is in the molten state to obtain uniform dispersion of the agent in the molten plastic. Preferably the blowing agent is added before the extrusion process and is in the form of a solid. The temperature and pressure to which the foamable composition of the invention are subjected to provide a foamed composition will vary within a wide range, depending upon the amount and type of the foaming agent, resin, and cellulosic fiber that is used. Preferred foaming agents are selected from endothermic and exothermic varieties, such as dinitrosopentamethylene tetramine, p-toluene solfonyl semicarbazide, 5-phenyltetrazole, calcium oxalate, trihydrazino-s-triazine, 5-phenyl-3, 6-

dihydro-1,3,4-oxadiazin-2-one, 3,6-dihydro 5,6-diphenyl-1,3,4 oxadiazin-2-one, azodicarboamide, sodium bicarbonate, and mixtures thereof.

In addition to the above, a coloring agent can be added to the compounded mixture, such as dyes, colored pigments, or flyash, or a mixture of these ingredients depending on the resulting color, and cost considerations. Such additives can provide "weatherability" or a faded greyish coloring or a permanent tint, such as blue, green or brown. This invention can be further understood by reference to the following examples.

EXAMPLES

Examples 1-16 were formulated and extruded into test boards. Mechanical properties of each formulation were measured and compared.

Table I - Parts per hundred parts resin (PHR), and

Weight per cent (WT%) vs.

Property of Selected Formulations

	PHR				WT%				PROPERTY		
FORMULATION	RIGID PVC CMPD	WOOD FLOUR	ACRYLIC MODIFIER	BLOWING AGENT	RIGID PVC CMPD	WOOD FLOUR	ACRYLIC MODIFIER	BLOWING AGENT	SPECIFIC GRAVITY (g/cc)	FLEX MODULUS (psi)	FLEX STRENGTH (psi)
1	100	68	4	0.5	57.97	39.42	2.32	0.29	1.16	421037	4823
2	100	100	10	0.5	47.51	47.51	4.75	0.24	1.07	398042	4286
3	100	100	4	1.5	48.66	48.66	1.95	0.73	1.09	297233	3397
4	100	68	10	1.5	55.71	37.88	5.57	0.84	0.83	205162	3158
5	100	100	4	0.5	48.90	48.90	1.96	0.24	1.17	357212	3790
6	100	68	10	0.5	56.02	38.10	5.60	0.28	1.09	457829	5353
7	100	68	4	1.5	57.64	39.19	2.31	0.86	1.06	287530	3964
8	100	84	7	0.5	52.22	43.86	3.66	0.26	1.11	431283	4769
9	100	84	4	1	52.91	44.44	2.12	0.53	1.02	260310	3386
10	100	68	7	1	52.08	43.75	3.65	0.52	0.98	270421	3597
11	100	100	10	1.5	47.28	47.28	4.73	0.71	0.94	224739	3058
12	100	100	10	1	47.39	47.39	4.74	0.47	0.99	256923	3207
13	100	84	10	1.5	51.15	42.97	5.12	0.77	0.89	227991	3124
14	100	100	7	1.5	47.96	47.96	3.36	0.72	0.97	271955	2996
15	100	68	10	1	55.87	37.99	5.59	0.56	0.93	305704	4014
16	100	84	10	0.5	51.41	43.19	5.14	0.26	1.08	430736	4747

In comparing the properties, it was noted that to obtain a target flexural modulus of about 200,000 psi, the following preferred formula was used.

TABLE II: PREFERRED FORMULA

	PPH PVC COMPOUND
Rigid PVC Compound	100
20-30 Mesh Hardwood Flour	68
Acrylic Modifier	10.0
Chemical Blowing Agent	1.5
Carbon Black	.18

This formulation provided the most optimum combination of cost efficiency and mechanical properties.

From the foregoing, it can be realized that this invention provides improved foamed polymer wood composite materials which provide lower specific gravity and high flexural modulus while permitting countersinking of screw fasteners. They also have great durability and strength. Although various embodiments have been illustrated, this is for the purpose of describing, but not limiting the invention. Various modifications will become apparent to one skilled in the art, and are within the scope of this invention described in the attached claims.

PATENT

We Claim:

1. A foamed polymer fiber composite building material, comprising: about 35-75 wt.% polymeric resin; about 25-65 wt.% fiber, and a specific gravity of less than about 1.25 g/cc, said composite building material including at least 1% porosity by volume of solids resulting from the addition of a gaseous medium or blowing agent to a molten precursor of said composite building material.

2. The wood composite building material of claim 1 further comprising an additive for improving the melt strength of said molten precursor.

3. The composite building material of claim 2 wherein said additive comprises an acrylic modifier.

4. The composite building material of claim 1 wherein said fiber comprises cellulosic fiber.

5. The composite building material of claim 1 wherein said molten precursor comprises about 0.1 to 2 wt.% of a chemical blowing agent and about .1 - 15 wt.% of an acrylic modifier.

6. The composite building material of claim 1 further comprising about 5-40% porosity by volume of solids.

7. The composite building material of claim 6 wherein said building material has a specific gravity of about .5-1.2 g/cc.

8. The composite building material of claim 1 further comprising an additive for producing a weathered appearance to said building material, said additive selected from the group comprising: a dye, pigment, flyash or a mixture thereof.

9. The composite building material of claim 1 including a flexural modulus of about 100,000 to 450,000 psi

10. A foamed polymer - wood composite, formed from a molten mixture comprising: about 35 - 75 wt.% polymeric PVC resin, about 25 - 65 wt.% wood fiber, and a blowing agent or gaseous medium, said molten mixture forming a polymer - wood composite having a specific gravity of less than about 1.25 g/cc, and a flexural modulus of about 100,000 - 450,000 psi.

11. The composite of claim 10 further comprising an additive for improving the melt strength of said molten mixture during extrusion.

12. The composite of claim 10 wherein said blowing agent comprises about 0.1 - 2.0 wt.% of a chemical blowing agent.

13. The composite of claim 12 wherein said chemical blowing agent is mixed into said polymeric resin and wood fiber during compounding, or at about the feet throat of an extruder.

14. The composite of claim 10 whereby said blowing agent produces a plurality of pores or cells within said composite for permitting a screw to be fastened flush to a surface of said composite without predrilling.

15. A method of forming a foamed polymer-cellulosic composite building material, comprising:

(a) compounding about 35 - 75 wt.% polymeric resin, about 25 - 65 wt.% cellulosic fiber, and about 0.1 to 2 wt.% of a blowing agent to form a compounded mixture;

(b) feeding said compounded mixture into an extruder, whereby said blowing agent becomes decomposed, disbursing a gas into said compounded mixture as it melts; and

(c) extruding said molten mixture containing said gas through a die whereby said gas forms tiny bubbles which are trapped within said polymer-cellulosic fiber composite.

16. The method of claim 15 wherein said compounded mixture further comprises a high molecular weight acrylic modifier for increasing melt elasticity and strength.

17. The method of claim 15 wherein said die comprises a generally board-shaped cross section.

18. A foamed polymer wood composite building material having a generally board-shaped cross-section, formed from a molten precursor comprising: about 45-60 wt.% of a polyvinyl-chloride resin, about 35-55 wt.% wood flour, about .1-15 wt.% acrylic modifier; and about .1-2.0 wt.% of a chemical blowing agent; said building material having a specific gravity of less than about 1.25 g/cc and permitting a screw to be fastened flush to a surface of said building material without predrilling; said building material also comprising a flexural modulus of about 100,000-450,000 psi.

19. The composite building material of claim 18 wherein said polyvinyl-chloride resin comprises a compounded resinous mixture.

20. The composite building material of claim 18 wherein said building material comprises a pigment for producing a weathered wood-gray appearance.

ABSTRACT

Foamed polymer-fiber composites, building materials and methods of making such building materials are provided by this invention. The composites include about 35-75 wt.% of a polymeric resin, about 25-65 wt.% fiber and have a specific gravity of less than about 1.25 g/cc. The low density is provided by the introduction of a blowing agent or gas into a molten precursor of the composite during thermo forming, such as in an extrusion operation.

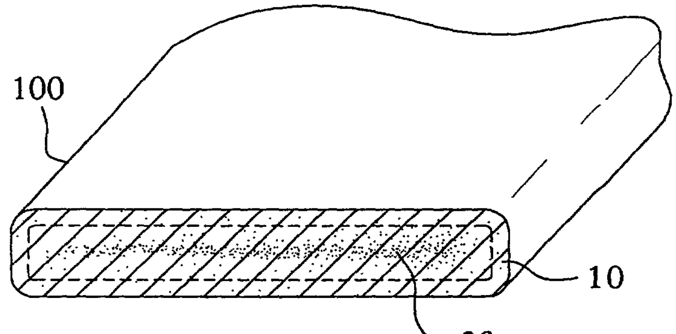

FIG. 1

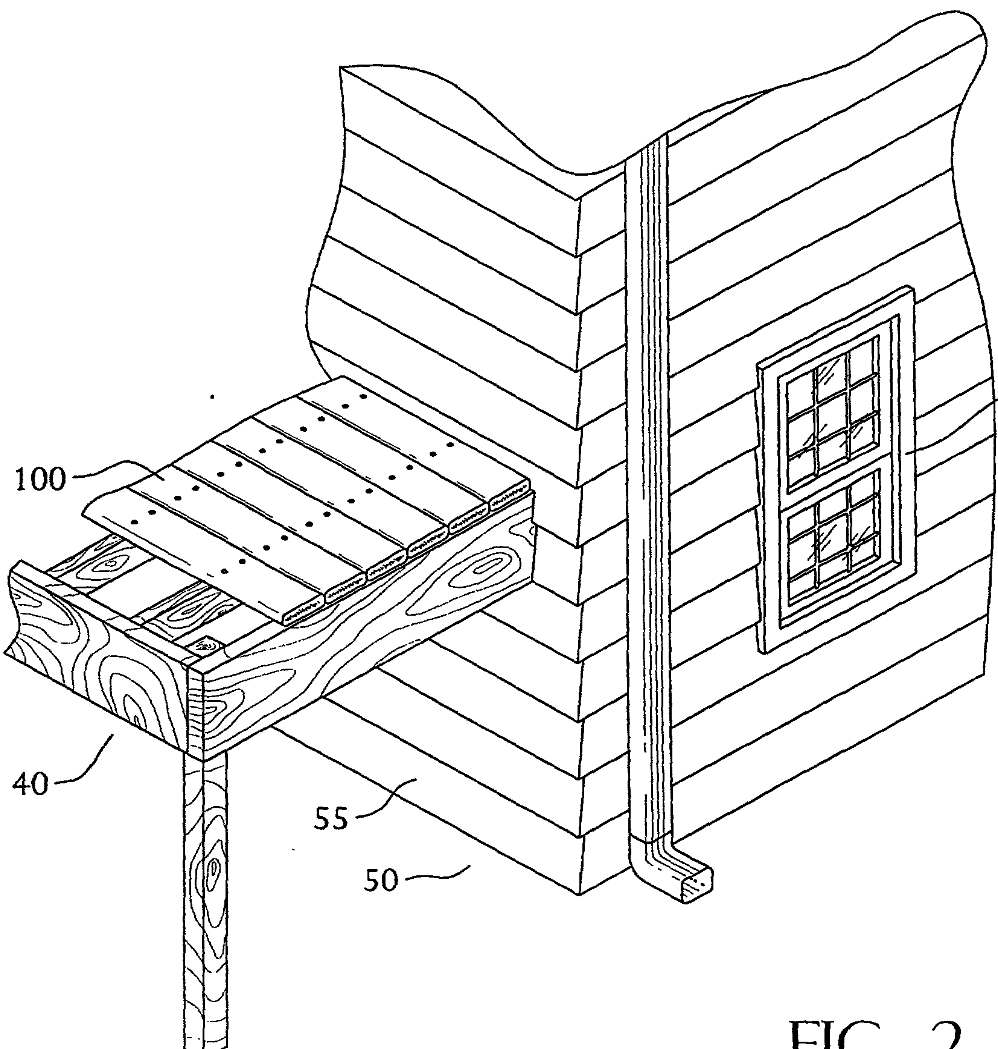

FIG. 2

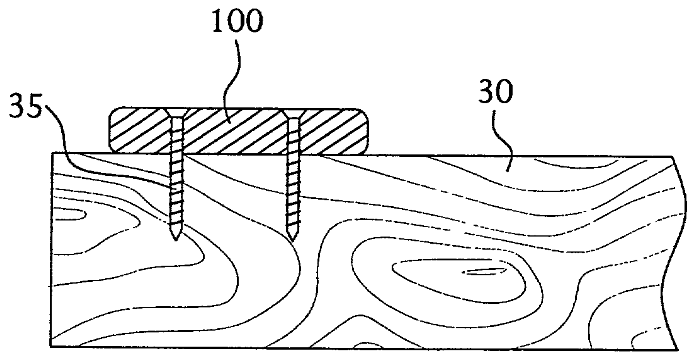

FIG. 3

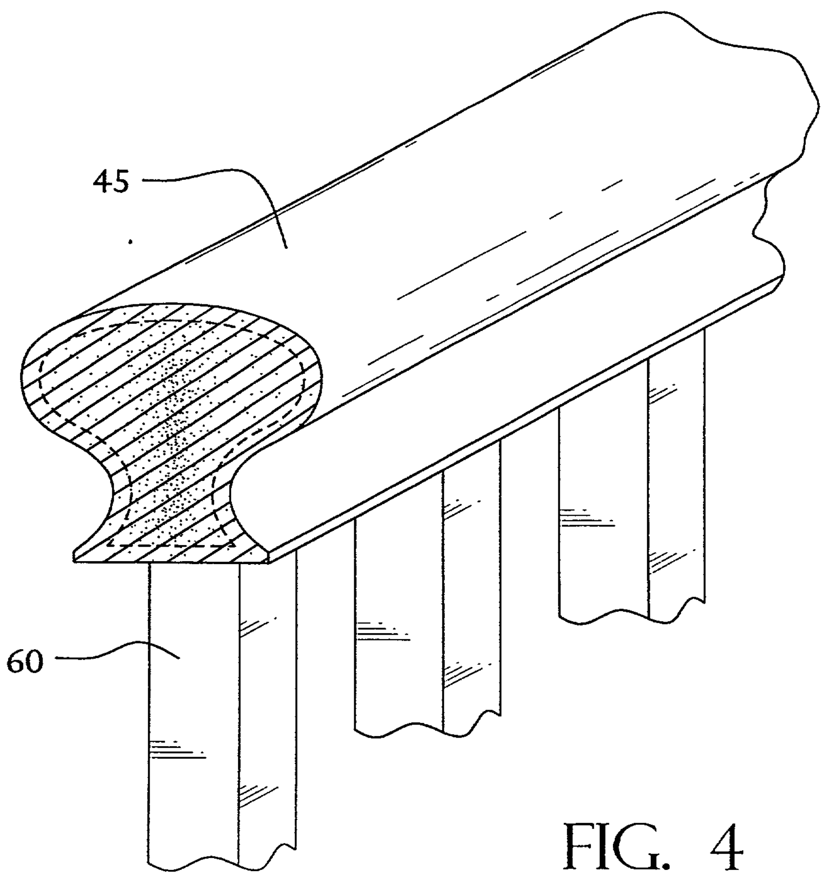

FIG. 4

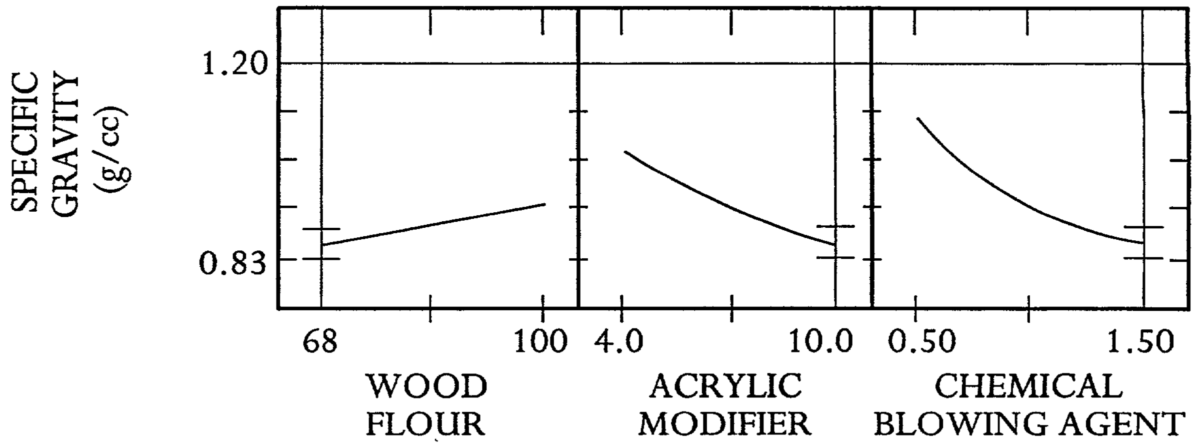

FIG. 5 FIG. 6 FIG. 7

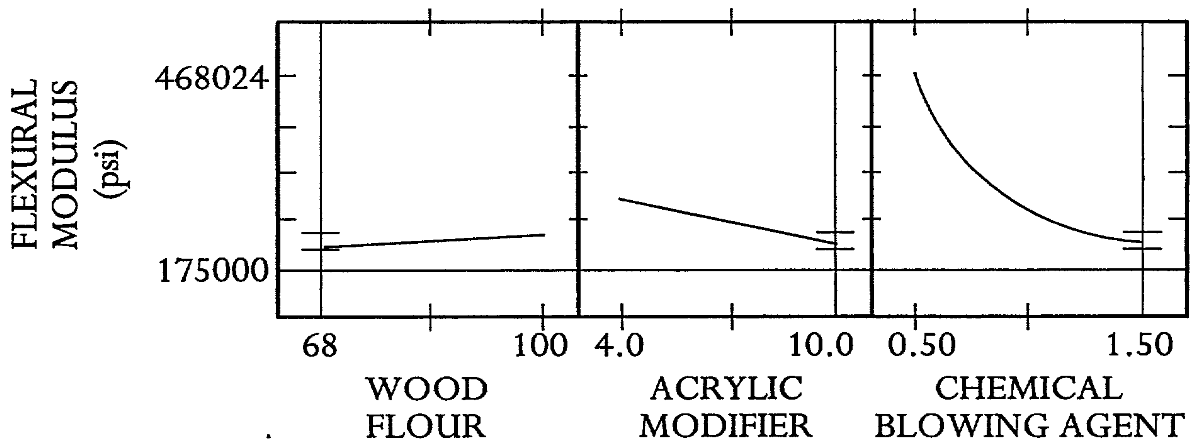

FIG. 8 FIG. 9 FIG. 10

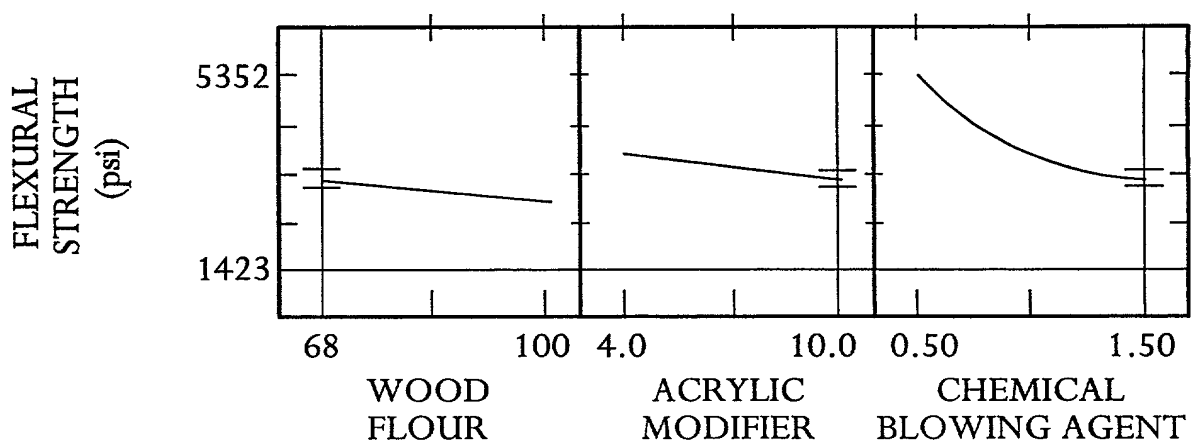

FIG. 14 FIG. 15 FIG. 16